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Cognitive consequences of expressive regulation in older adults

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ABSTRACT

Previous research has suggested that older and young adults are equally able to regulate their outward expressions of emotion and that the regulation of emotional expression in younger adults results in decreased memory for the emotional stimulus. In the current study, we examined whether older adults show this same memory effect. Older and young adults viewed positive and negative emotional pictures under instructions to view the pictures naturally, enhance their facial expressions, or suppress their facial expressions. Older and young adults showed equivalent outward regulation of expression, but suppressing their emotional expressions led to reduced memory for emotional stimuli only in the young adults. The results suggest that older and young adults are achieving control of their expressions through different mechanisms or strategies.

The ability to control one's outward expressions of emotion has been a topic of interest across both the general psychological literature and among those studying developmental processes in adulthood. Being able to flexibly enhance and suppress one's expressions as warranted by the situation has been linked to better social adjustment (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004). Studies suggest that when younger adults effectively regulate their outward emotional expressions, they show minimal changes in actual emotional feelings but show increased physiological arousal and cognitive costs in the form of decreased memory for the arousing stimuli (Richards, 2004). In the aging literature, research to date has shown that older and younger adults show similar emotional and physiological responses to expressive regulation (Kunzmann, Kupperbusch, & Levenson, 2005). No study, however, has examined the cognitive consequences of expression regulation in older adults. Current research on the broader construct of emotion regulation suggests that older adults may approach emotional situations differently than younger adults and may find other types of emotion regulation less cognitively costly (Scheibe & Blanchard-Fields, 2009). In the current study, therefore, we examine potential age differences in the impact of expression control on memory for emotional material.

EXPRESSIVE REGULATION AND ITS COGNITIVE CONSEQUENCES

The majority of research on the consequences of expression regulation has focused on the strategy of expressive suppression or preventing an outwardly visible reaction in response to an emotional event or stimulus. A smaller body of work has examined expressive enhancement or exaggerating a naturally occurring emotional expression. Both expressive suppression and enhancement have been described as response focused strategies of emotion regulation (Demaree, Robinson, Pu, & Allen, 2006; Gross & Thompson, 2007), in which the attempt to control the expression is through direct control of the facial muscles. These expressive regulation strategies may be contrasted with antecedent focused emotion regulation strategies such as situation selection (e.g., choosing to avoid a potentially unpleasant situation in the first place) or cognitive reappraisal of a situation (e.g., deciding that you will think about the unpleasant situation in a way that is not upsetting), which are directed at controlling the initiation or appraisal of an emotional response (Gross & Thompson, 2007). Although antecedent regulation strategies such as reappraisal may also reduce the expression of emotion (e.g., Phillips, Henry, Hosie, & Milne, 2008; Richards & Gross, 2000), they influence the facial expression indirectly, through control of thoughts, rather than directly, through the control of muscles.

In research using college students, both expressive suppression and expressive enhancement have been found to have minimal to negative consequences for affective feelings. Suppression and exaggeration of expression in response to negative stimuli generally do not change subjective reports of affect (e.g., Bonanno et al., 2004; Demaree, Schmeichel, Robinson, & Everhart, 2004; Gross & Levenson, 1993; Richards & Gross, 2000). In contrast, the suppression of response to positive stimuli results in reports of decreased positive affect (Gross & Levenson, 1997), although exaggeration in response to positive stimuli does not appear to impact affect

(Demaree et al., 2004). The ineffectiveness of expressive regulation on changing internal feelings suggests that this type of regulation is not aimed at reducing feelings but is aimed at either hiding or communicating the emotional response from/to others.

In contrast to reported feelings, both expressive suppression and enhancement have been found to increase physiological arousal. Laboratory participants who are instructed to suppress or exaggerate their facial expressions in response to positive or negative stimuli tend to show increases in measures of sympathetic nervous system activation compared to participants in unregulated control conditions (Demaree et al., 2004; Gross & Levenson, 1997).

The cognitive consequences of expressive regulation have been studied primarily using subsequent memory for the emotional material. In college students, the act of controlling one's facial expressions has been shown to lead to reduced memory for the emotional event. Several experimental studies have shown that when participants are instructed to suppress their expressions in response to either positive or negative stimuli, they later show impaired memory for those stimuli (Bonanno et al., 2004; Dillon, Ritchey, Johnson, & LaBar, 2007; Richards & Gross, 2000). Similarly, although there is less research on the impact of enhancement on memory, at least one study has shown that enhancement of facial expressions also results in reduced memory performance (Bonanno et al., 2004).

This reduced memory in response to the control of facial expressions has generally been regarded as an indication of attention to the emotional stimulus. That is, it is assumed that the goal of regulating facial expression causes a diversion of attention from the processing of the stimuli to the control of behavior (Richards, 2004), and this reduction in stimulus processing thus reduces memory for the stimuli (Dillon et al., 2007). This effect of expressive regulation on memory can be contrasted with the effect of other strategies aimed at regulation of emotion. For example, thinking about the stimulus in a way that either increases or decreases emotional feelings has been shown to increase memory for the stimulus (Dillon et al., 2007). Thus, both types of regulation have a different impact on memory through the same mechanism: either attention is drawn away from the stimulus (e.g., expressive suppression) or toward the stimulus (e.g., cognitive reappraisal). This effect of attention is thought to be overlaid on the general and automatic effect of arousal on memory (Dillon et al., 2007). That is, emotional (arousing) stimuli are better remembered than are nonarousing stimuli (e.g., Phelps, 2006), regardless of whether or which regulation strategy is employed. Regulation will instead determine how much better the arousing stimuli are remembered. Cognitive reappraisal, which encourages elaborative processing, results in greater recall of emotional material than no regulation, but expressive regulation, which diverts attention from the stimulus, results in worse recall than no regulation.

AGING AND EXPRESSIVE REGULATION

To our knowledge, three published studies have examined age differences in the ability to suppress and enhance facial expressions of emotion (Kunzmann et al., 2005; Magai, Consedine, Krivoshekova, Kudadjie-Gyamfi, & McPherson, 2006; Phillips et al., 2008), though as in the young adult literature most of the emphasis has been on suppression rather than exaggeration, and on between-subjects rather than on within-subjects experiments. In these studies, researchers found that older and younger adults are equally able to suppress and enhance their facial expressions when asked to do so. Age equivalencies in the regulation of emotional expression can be contrasted with age differences in emotion regulation strategies that are focused on avoiding the initiation of emotion itself or changing the appraisal of an emotional situation. For example, older adults are more likely to report that they avoid emotionally charged confrontations when such confrontations may be destructive (e.g., Birditt & Fingerman, 2005), may be more likely to use selective attention deployment to avoid looking at emotionally negative information (Mather & Knight, 2005), and may both report using reappraisal more than younger adults (John & Gross, 2004; but see Beaudreau, MacKay, & Storandt, 2009; Emery & Hess, 2008) and be more effective at using reappraisal when asked to do so (Phillips et al., 2008). Thus, older and younger adults appear to differ in their use of regulation strategies to control their inward feelings of emotion, but they appear equally able to regulate their outward expressions of emotion when asked to do so. There are, however, some limitations to the previous expressive regulation studies that limit interpretation of this finding and serve as the inspiration for the current research.

The first limitation of the previous research and the primary focus of the current study is that none of the studies to date have examined the cognitive consequences of expressive regulation in older adults. As described in the previous section, expression regulation in younger adults appears to have the cognitive consequence of reduced memory for the emotional stimuli, an effect that has previously been linked to the redirection of attention from processing the stimulus to controlling behavior. Examining subsequent stimulus memory after expressive regulation may provide evidence regarding whether the age groups differ in the strategy by which they choose to control their expressivity. For example, Magai et al. (2006) suggested that older adults rather than relying on muscle control to reduce their expressivity may instead choose to regulate their expression by controlling the emotional experience itself. If this is the case, older adults may show a reduced cognitive cost of expressive regulation than do younger adults.

In addition, in each of the previous three studies there have been baseline age differences in self-reported affect and observer ratings of emotional expressiveness. Two of the studies (Kunzmann et al., 2005; Phillips et al., 2008) have asked older adults to either suppress and/or enhance their facial expressions in response to emotional films. Both of these studies found age differences during the no-regulation conditions (higher self-rated affect and more expressiveness for the young in Kunzmann et al., 2005; higher self-rated affect and more expressiveness for the old in Phillips et al., 2008), despite finding age equivalence in affect and expression during the regulation conditions. The difference in direction for the two studies is likely the result of the type of materials used (disgust-evoking videos vs. social injustice videos, respectively). In the third study (Magai et al., 2006), participants were asked to recall and describe autobiographical events that made them either sad or angry; half of the participants were asked to suppress their facial responses while telling their stories. Younger adults showed more expressiveness than did older adults for several emotions during both the no-regulation and the suppression conditions. In addition, older adults both reported a greater intensity of emotion and used more emotional words during the no-regulation condition than during the suppress condition. Only one study (Kunzmann et al., 2005) examined physiological responding and found that older and younger adults showed similar reactivity to both suppress and enhance instructions. Although the direction of the age difference varies among the studies, these underlying baseline differences imply that regulation may have been more difficult for one age group than the other in these studies (Kunzmann et al., 2005; Phillips et al., 2008).

The final limitation of the previous studies is that all three studies have examined expressive regulation using only negatively valenced material. This is an important limitation for two related reasons. First, several studies have suggested that older and younger adults may have different reactions to and memory for positive and negative stimuli (e.g., Charles, Mather, & Carstensen, 2003; Mather & Knight, 2005). Specifically, older adults may show a positivity effect in which they may show a bias toward processing positive stimuli and/or away from processing negative stimuli (e.g., Mather & Carstensen, 2005). It is possible, therefore, that age differences in expressive regulation may emerge in response to positive stimuli. Second, although older adults appear to have no difficulty enhancing their reactions to a negatively valenced film (Kunzmann et al., 2005), at least one recent study has shown that older adults may have difficulty enhancing their facial reactions to positive material (Henry, Rendell, Scicluna, Jackson, & Phillips, 2009). Henry et al.(2009) found that older adults' facial expressions in response to an amusing film were not significantly different in a no-control condition compared to an exaggerate condition. However, Henry et al. did not have a young adult comparison group to determine whether there were significant age differences in this effect (the older adults were a control group for a group of patients with probable Alzheimer's disease).

THE CURRENT STUDY

We designed the current study to address the limitations outlined above. Our primary goal was to examine the cognitive costs of expressive suppression and enhancement in older and younger adults. To do this, we adopted the expressive flexibility paradigm used by Bonanno et al. (2004). In this within-subjects paradigm, participants are shown blocks of positive and negative pictures from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2001) under three different instructions: Suppression, Enhancement, or “Natural” viewing instructions. Each participant's expressivity and affect during the two regulation conditions can then be compared with their own expressivity under the natural nonregulation condition to examine the consequences of expressive regulation. Later, participants were given a surprise recall test for the pictures presented; we could then compare recall of pictures that came from each condition to determine whether expressive regulation impacted memory differently in older and younger adults. This paradigm allowed us to address the remaining limitations of previous studies that were outlined above: We chose materials that resulted in age equivalence in the natural condition and used material that was both positively and negatively valenced.

METHOD

Participants

Older adult participants (n = 57; age = 60–81) were recruited from the Raleigh, North Carolina, metro area using newspaper advertisements and received $20 for participation. Younger adults (n = 51; age = 18–37) were recruited from introductory psychology classes at North Carolina State University and received course credit for participation. During the course of the study, participants were screened for possible memory problems using the Short Blessed Orientation–Memory–Concentration Test (Katzman et al., 1983) and for possible depression using the short version of the Geriatric Depression Scale (Sheikh & Yesavage, 1986). Following conventional suggestions (Lezak, Howieson, & Loring, 2004), participants who scored above 6 on the Short Blessed Orientation–Memory–Concentration Test or above 9 on the Geriatric Depression Scale were excluded from analysis. This resulted in the exclusion of three younger and four older participants, with 48 younger adults (27 women) and 53 older adults (27 women) comprising the final study sample.

Participant characteristics for each age group are presented in Table 1 Our sample showed typical age differences in education, physical and mental health (SF-36 Health Survey; Ware, 1993), vocabulary (Wechsler Adult Intelligence Scale—Third Edition [WAIS-III] Vocabulary subtest; Psychological Corporation, 1997), processing speed (WAIS-III Digit-Symbol Substitution), and abstract reasoning (WAIS-III Matrix Reasoning) as well as commonly found age differences in positive and negative affect (Positive and Negative Affect Schedule; Watson, Clark, & Tellegen, 1988). Although the older adults had lower working memory capacity (Operation Span scores; Turner & Engle, 1989), the age difference failed to reach significance, $t(96) = 1.82$, $p = .07$. Finally, our participants did not show age differences in reported use of the emotion regulation strategies of reappraisal and suppression (Emotion Regulation Questionnaire; Gross & John, 2003).

Table 1
Participant Characteristics

Characteristic	Younger *M*	Younger *SD*	Older *M*	Older *SD*
Age	19.54	3.85	70.89	4.75
Education[a]	12.75	0.96	16.42	2.41
SF-36: Physical Health[a]	51.25	4.16	45.25	9.11
SF-36: Mental Health[a]	50.03	8.63	56.56	6.84
Digit-Symbol Substitution[a]	86.57	10.14	61.72	12.04
Vocabulary[a]	45.19	9.033	53.00	6.69
Matrix Reasoning[a]	20.55	2.62	15.28	5.00
Operation Span[b]	27.46	8.29	24.36	8.59
ERQ: Suppression	13.92	5.07	13.42	5.14
ERQ: Reappraisal	29.23	5.89	30.36	5.63
PANAS: Positive Affect[a]	30.60	6.52	34.96	6.71
PANAS: Negative Affect[a]	12.73	3.00	11.40	2.13

Note. ERQ = Emotion Regulation Questionnaire; PANAS = Positive and Negative Affect Schedule.
[a] Age difference significant at $p < .05$. [b] Age difference at trend level, $p < .10$.

Apparatus

All computer-administered portions of the experiment were run on a desktop microcomputer using E-Prime software (Version 1.1; Psychology Software Tools, Sharpsburg, PA). Video recording of participants was done using a Sony Handycam camcorder (Model DCR-SR40) mounted on a tripod behind the computer monitor.

Materials

Negative and positive pictures were chosen from the IAPS (Lang et al., 2001). The IAPS valence ratings for the pictures used were significantly different across valence categories, $t(34) = 26.54$, $p < .001$, with positive pictures ($M = 7.28$, $SD = 0.44$) rated more highly than negative pictures ($M = 2.97$, $SD = 0.53$). IAPS arousal ratings did not differ across negative and positive pictures, $t(34) = 0.09$, $p = .93$ (positive pictures: $M = 6.04$, $SD = 0.54$; negative pictures: $M = 6.03$, $SD = 0.38$).

After viewing blocks of pictures, participants rated how “happy or unhappy” they felt and how “excited or calm” that they felt using Self-Assessment Manikins (SAMs; Bradley & Lang, 1994) on a 5-point scale. The five “happy to unhappy” SAMs were arranged with the “happiest” SAM on the left (score of 1) and the “unhappiest” SAM on the right (score of 5). The five “excited or calm” SAMs were arranged with the “excited” SAM on the left (score of 1) and the “calm” SAM on the right (score of 5).

Procedure

After filling out some background questionnaires, participants completed the Positive and Negative Affect Schedule, with the instruction to indicate to what extent they felt that way today. Participants were then given the instructions for the emotion regulation task. Participants were told that they would be viewing pictures on the computer screen and at different times would be asked either to view the pictures naturally or would be asked to control their facial expressions in certain ways. They were told that before each group of pictures they would be given one of three instructions telling them what to do. Participants were then given the following directions for each instruction:

Natural means that you should watch the next group of pictures as if you encountered them in your daily life, for example, as if you were watching them on television.

Suppress means that while you are watching the pictures, you should do your best to not show any emotional expression on your face. In other words, if someone were watching your face, they should not be able to tell what you are feeling.

Enhance means that while you are watching the pictures, you should do your best to exaggerate the facial expression of the emotion the picture evokes. In other words, if someone were watching your face, [he or she] should have no difficulty telling what you are feeling.

Participants were then told that after each group of pictures, they would be asked to rate both how “happy or unhappy” and how “excited or calm” they felt, using the SAMs described above. After the instructions were complete, participants were given three practice blocks to be sure they understood the instructions. During the practice blocks, we used smiley faces as stimuli rather than IAPS pictures to avoid later memory contamination.

During the emotion regulation task, participants saw six blocks (3 instructions [neutral, suppress, enhance] × 2 valences [positive, negative]) of 6 pictures each. The order of the blocks was randomly determined for each participant. For each level of valence, the pictures within each block were also randomly determined for each participant. Each block started with a 3-s instruction, and then the six pictures were presented one after the other for 5 s each. After each block, participants made their happy–unhappy and then excited–calm ratings at their own pace using a five-button response box. The experimenter was present in the room but out of the line of sight of the participant during this task.

Following the emotion regulation task, participants completed the Short Blessed Orientation–Memory–Concentration Test, Operation Span, and WAIS-III Digit-Symbol Substitution Test. Participants were then given a surprise recall test in which they were asked to recall all of the pictures that they could remember from the emotion regulation task (excluding the practice smiley faces) by writing down a description of each picture in as much detail as possible. Finally, participants completed the vocabulary and matrix reasoning tasks.

Data Coding

Emotional expressivity

Trained undergraduate raters coded each of the six video segments for each participant; two raters coded each segment. The raters were blind to the instructions that the participants were given and the pictures they were viewing. The coding procedure was adapted from that used by Kunzmann et al. (2005). Because the stimuli in this study were not chosen to evoke single specific emotions, the raters coded the participants' expressivity during each segment using three scales: Pleasant Expressivity (e.g., expressions of happiness), Unpleasant Expressivity (e.g., expressions of anger, sadness, disgust, or fear) and Overall Expressivity (emotional expressivity regardless of valence, including surprise). For each scale, raters coded both the intensity and frequency of a participant's facial expressions on a scale from 0 (*no sign of emotional expression*) to 4 (*more than one high intensity sign of emotional expression*); raters assigned one code from each scale to each of a participant's six video segments. To ensure that participants understood what constituted a pleasant or unpleasant expression and what expressions of low, medium, and high intensity were, we had the raters study examples of expressions of different emotions and intensities from Ekman and Friesen's (1975)*Unmasking the Face: A Guide to Recognizing Emotions From Facial Clues*. Raters were carefully instructed to rate a participant's expressivity based on the specific criteria discussed in training, and not to code the participant's expressivity in one segment relative to his or her expressivity in another segment. Interrater reliability was good overall (average weighted $\kappa = .81$). The coder ratings were averaged for analysis.

Picture recall

Coding of the recall responses was done using the exact procedure in Emery and Hess's (2008) study. Briefly, two undergraduate coders (blind to the age of the participant) independently tried to match each response to one of the pictures presented over the course of the experiment. Because the order of the pictures varied randomly across participants, coders did not know which picture was presented in which condition. If the response did not match any pictures, the coders marked a “no match.” If the two coders disagreed on any response, a third undergraduate coder also attempted to match the response to a picture. Any responses for which all three raters disagreed were coded as “disagreements.”

After the coding procedure was complete, the responses that had been successfully matched to a picture were then matched back to the condition in which they had been presented. Because neither “no match” nor “disagreement” responses could be matched back to a condition, these responses had to be discarded from analysis. [1]

RESULTS

Each dependent variable was analyzed with a 2 × 2 × 3 (Age Group [old vs. young] × Valence [negative vs. positive] × Instruction [enhance vs. natural vs. suppress]) analysis of variance (ANOVA), with the significance level set to $p = .05$. For all analyses, any ANOVA result with a p value between .05 and .10 is reported as a trend.

Emotional Expressivity Ratings

Because of a recording problem, video data from five participants were lost. As may be seen in Figure 1, unpleasant and pleasant expressivity showed essentially the same results: The ANOVA for each measure showed main effects of instruction (unpleasantness: $F[2, 188] = 106.04$, $p < .05$, $\eta^2_p = .53$; pleasantness: $F[2, 184] = 108.07$, $p < .05$, $\eta^2_p = .54$), valence (unpleasantness: $F[1, 94] = 103.09$, $p < .05$, $\eta^2_p = .52$; pleasantness: $F[1, 94] = 87.59$, $p < .05$, $\eta^2_p = .48$), and an Instruction × Valence interaction (unpleasantness: $F[2, 188] = 30.57$, $p < .05$, $\eta^2_p = .24$; pleasantness: $F[2, 188] = 42.05$, $p < .05$, $\eta^2_p = .31$). No other effects were significant in either ANOVA (ps > .10).

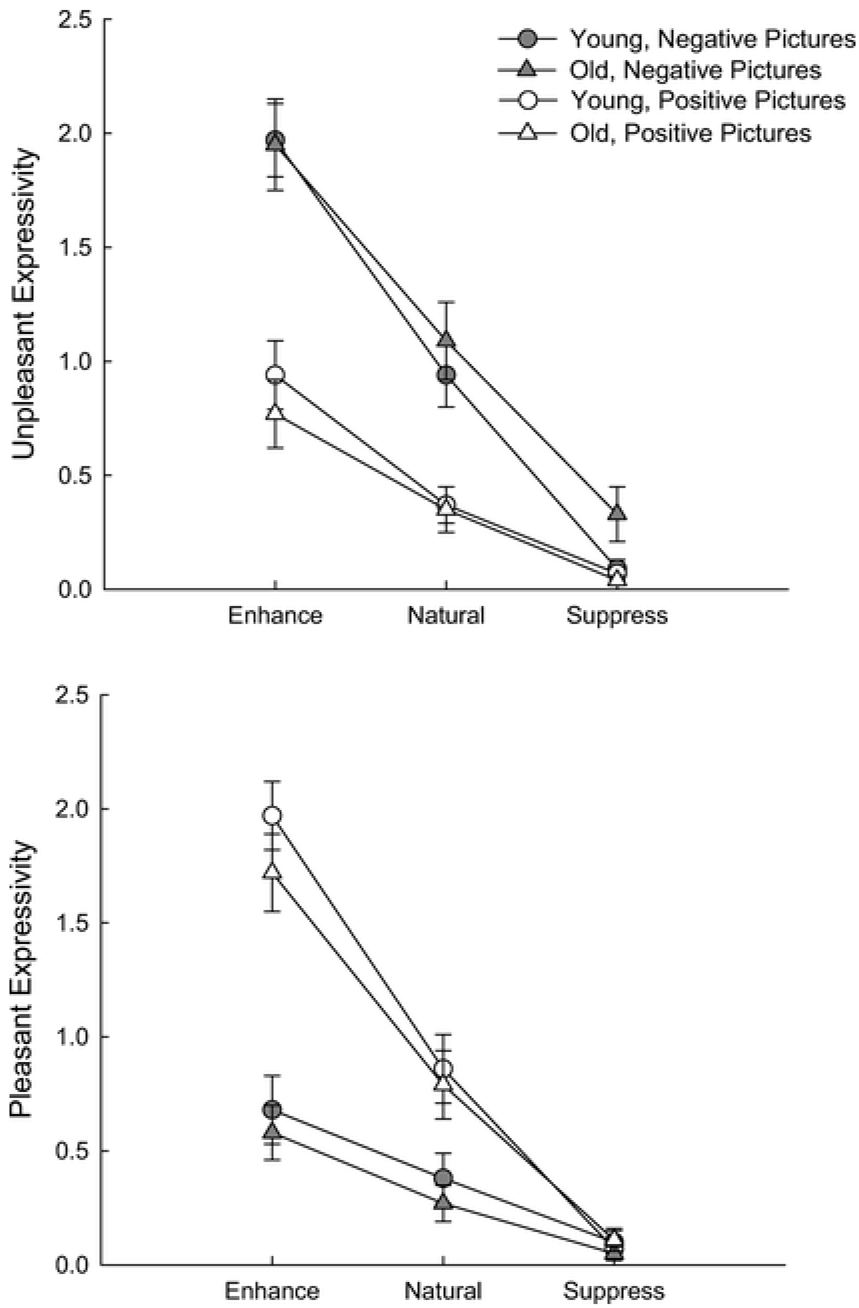

Figure 1. Average unpleasant (top) and pleasant (bottom) expressivity shown by younger and older adults across conditions. Error bars are standard errors.

Overall, participants showed more unpleasant expressivity for negative than positive pictures, and showed the appropriate modulation of unpleasant expressivity in the enhance and suppress conditions, relative to the neutral conditions. Participants showed significant differences in unpleasant expressivity across instructions for both positive and negative pictures; however, the Instruction × Valence interaction indicates that the difference in unpleasant expressivity for negative and positive pictures increased across instructions, such that there was no effect of valence under suppress instructions and the largest effect of valence was in the enhance instructions. This same pattern was found for pleasant expressivity, with the exception that participants showed more pleasant expressivity during the positive than negative pictures, as expected. This overall pattern of results is reflected in the coders' ratings of overall expressivity, which showed only main effects of instruction, $F(2, 188) = 166.02$, $p < .05$, $\eta^2_p = .64$, and valence, $F(1, 94) = 8.25$, $p < .05$, $\eta^2_p = .08$. The valence effect indicates that participants were slightly more expressive for negative than positive pictures.

Of particular importance is the lack of age effects in the expressivity measures; across the three expressivity measures, all main effects and interactions involving age showed very small and nonsignificant effect sizes ($\eta^2_p < .03$; in all but two cases $\eta^2_p < .01$). Older and younger adults showed equal overall expressivity in the natural condition, $t(94) = .54$, $p = .59$, and showed equal moderation of expressivity across instructions and across valence, $F(2, 188) = 0.09$, $p = .91$. Thus, older and young adults' outward behavior was equivalent in all aspects. [2]

Affect and Arousal

Self-rated unhappiness

Mean scores for participants' unhappiness ratings are presented in the top portion of Table 2 The ANOVA detected significant main effects of instruction, $F(2, 198) = 5.95$, $p < .05$, $\eta^2_p = .06$, and valence, $F(1, 99) = 169.93$, $p < .05$, $\eta^2_p = .63$, an Instruction × Valence interaction, $F(2, 198) = 3.99$, $p < .05$, $\eta^2_p = .04$, and an Instruction × Valence × Age Group interaction, $F(2, 198) = 3.65$, $p < .05$, $\eta^2_p = .04$. No other effects were significant (*p*s > .10).

Table 2

Means and Standard Deviations for Unpleasantness Ratings

	Younger adults				Older adults			
	Negative pictures		Positive pictures		Negative pictures		Positive pictures	
Instruction	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Enhance	3.33	1.08	1.85	0.68	3.36	1.11	1.91	1.00
Natural	3.38	0.96	2.04	0.65	3.38	0.96	1.89	0.89
Suppress	3.27	0.94	2.42	0.74	3.51	1.15	2.08	1.02

Means and Standard Deviations for Unpleasantness Ratings

As expected, participants were significantly more unhappy following negative pictures than following positive pictures. The main effect of instruction indicated that participants were significantly more unhappy in the suppress condition than in the natural condition, $F(1, 99) = 10.28$, $p < .05$, $\eta^2_p = .09$, but there was no difference in unhappiness between the enhance and natural conditions, $F(1, 99) = 0.53$, $p = .47$, $\eta^2_p = .01$. The Instruction × Valence interaction, however, indicated that this effect of instruction was only significant for positive pictures, *F*(2,

198) = 10.14, $p < .05$, $\eta^2_p = .09$, not negative pictures, $F(2, 198) = 0.16$, $p = .85$, $\eta^2_p = .00$. Finally, the three-way interaction indicated that the effect of instruction on positive pictures was only significant in the younger adults, $F(2, 94) = 13.48$, $p < .05$, $\eta^2_p = .22$, not the older adults, $F(2, 104) = 1.32$, $p = .27$, $\eta^2_p = .02$. In summary, suppression caused younger adults to feel less happy after positive pictures than they did under natural conditions, but instruction had no other significant effects on affect. This effect in younger adults (suppression has no effect on negative feelings but results in a decrease in positive feelings) is similar to that found in previous studies with younger adults (e.g., Gross & Levenson, 1997). Suppression seemed to have no effect, however, on older adults' ratings of affect.

Self-rated calmness

The only significant effect for calmness was a main effect of instruction, $F(2, 198) = 6.62$, $p < .05$, $\eta^2_p = .06$. Follow-up contrasts indicated that participants reported being slightly less calm during the enhance condition ($M = 3.24$, $SD = 0.96$) than during the natural condition ($M = 3.44$, $SD = 0.91$), $F(1, 99) = 5.43$, $p < .05$, $\eta^2_p = .05$, and less calm in the natural condition than in the suppress condition ($M = 3.53$, $SD = 0.87$), $F(1, 99) = 8.18$, $p < .05$, $\eta^2_p = .08$. There was a nonsignificant trend toward a main effect of valence, $F(1, 99) = 2.97$, $p = .09$, $\eta^2_p = .03$, with higher mean calmness ratings during the positive ($M = 3.48$, $SD = 0.93$) than the negative ($M = 3.33$, $SD = 0.85$) conditions. No other effects were significant (*p*s > .10).

Picture Recall

Picture recall

Figure 2 reports the proportion of pictures from each instructional condition that were recalled by participants. [3] The ANOVA revealed significant main effects of age group, $F(1, 99) = 8.33$, $p < .05$, $\eta^2_p = .08$, and valence, $F(1, 99) = 47.18$, $p < .05$, $\eta^2_p = .32$, with younger adults ($M = 0.30$, $SD = 0.11$) recalling a greater proportion of the pictures than older adults, ($M = 0.24$, $SD = 0.11$), and participants recalling a greater proportion of the negative pictures ($M = 0.32$, $SD = 0.15$) than the positive pictures ($M = 0.22$, $SD = 0.13$). In addition, there was an Age Group × Instruction interaction, $F(2, 198) = 3.45$, $p < .05$, $\eta^2_p = .03$, and a trend toward an Instruction × Valence interaction, $F(2, 198) = 2.66$, $p = .07$, $\eta^2_p = .03$. No other effects were significant (*p*s < .10). Of particular importance, neither the Valence × Age Group interaction, $F(1, 99) = 1.61$, $p = .21$, $\eta^2_p = .02$, nor the Valence × Age Group × Instruction interaction, $F(2, 198) = 0.76$, $p = .46$, $\eta^2_p = .01$, approached significance, suggesting that the age groups did not differ in the ratio of positive to negative material recalled across the three conditions.

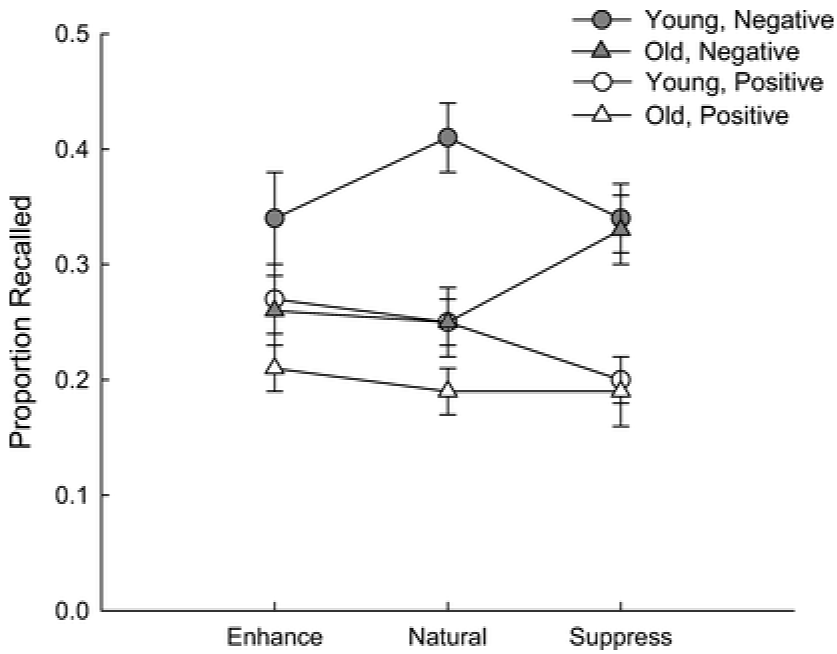

Figure 2. Average proportion of pictures recalled by younger and older adults across conditions. Error bars are standard errors.

To determine the nature of the Age Group × Instruction interaction, we conducted Age × Instruction contrasts comparing the enhance and suppress conditions to the natural condition. The Enhance × Natural contrast indicated that there were no significant effects of enhancement on memory in either age group (*p*s > .10), although the pattern of memory in younger adults was similar to that found by Bonanno et al. (2004), with reduced memory in the enhance condition. The increased variability of memory performance in the enhance condition may have made the effect more difficult to detect. [4] The Suppress × Natural contrast, however, did show a significant Age Group × Instruction interaction, $F(1, 99) = 5.35$, $p < .05$, $\eta^2_p = .05$. Consistent with previous research, suppression in the younger adults led to significantly poorer memory for the pictures relative to the natural condition, $F(1, 47) = 4.24$, $p < .05$, $\eta^2_p = .08$. In contrast, there was no significant difference between the natural and suppress conditions for the older adults; in fact there was a nonsignificant trend toward suppression causing improved memory in older adults, $F(1, 52) = 2.90$, $p = .09$, $\eta^2_p = .05$. As may be seen in Figure 2, the net result of the suppression condition was to eliminate age differences in memory, $F(1, 99) = 0.20$, $p = .67$, $\eta^2_p = .002$.

Figure 2 also indicates that the trend toward an Instruction × Valence interaction is likely due to the instructions primarily impacting memory for negative, not positive, material. Separate Age × Instruction ANOVAs conducted within each valence yielded no significant effects for positive pictures (all *p*s > .10) but a significant Age × Instruction interaction for the negative pictures, $F(2, 198) = 3.10$, $p < .05$, $\eta^2_p = .03$. We return to this point in the Discussion.

DISCUSSION

The primary goal of this study was to examine the cognitive costs of expressive regulation in older and younger adults. Although there were no age differences in outward expression and few age differences in the affective consequences of expressive regulation, there were significant age differences in how expressive suppression influenced subsequent memory. Older and younger adults showed identical effects of expressive regulation on outward expressions of emotion and on self-reported arousal, and for the most part similar effects on self-reported affect. Older and younger adults did show different effects of expressive regulation on memory: Younger adults showed reduced picture recall after suppression (as in previous research), but older adults did not.

Unlike previous studies of age differences in expressive regulation, in the current study older and younger adults were equivalent on both outward expressivity and subjective measures of affect and arousal during the natural viewing conditions. This implies that the age-related findings during the expressive regulation conditions were not due to baseline age differences in these measures. [5] It should be noted that both the affect ratings and the expressivity ratings were on the lower end of the scales in the current study, which may be one reason for the lack of age differences in the natural condition. This may limit the findings of the current study to situations of low emotional arousal, and future research should be directed at extending the current memory findings with more evocative stimuli (e.g., films).

Finally, we found that the valence of the stimuli had little effect on age differences in the consequences of expressive regulation. The only significant age difference arose in the affective responses to suppression of reactions to positive pictures. Unlike Henry et al. (2009), we did not find that older adults had difficulty enhancing their facial responses to positive stimuli, though this difference may be due to the lower level of baseline responding in the current study, as described above. We also did not find any significant Age × Valence interactions in the memory data. As noted above, however, the memory results are driven primarily by the impact of expressive regulation on memory for negative pictures. If suppression slightly reduces memory for negative pictures in younger adults but slightly increases memory for negative pictures in older adults, this could be seen as a reduction in the age-related positivity effect. That is, there is a net decrease in the proportion of positive information remembered in older adults under suppression instructions. Future research with larger sample sizes and/or different stimuli would be needed to determine whether this effect is reliable.

Expressive Regulation and Age Differences in Memory

The primary unique finding of this study is the differential impact of expressive suppression on memory in older and younger adults, despite age equivalence in the outward effectiveness of the regulation. This finding suggests that younger and older adults are using different strategies to regulate their expressivity. The strategy used in younger adults results in adequate expressive suppression at the cost of memory. The strategy used in older adults is equally effective at controlling expressivity but at no cost (and a possible benefit) to memory. Given the previously reviewed research on both expressive and emotion regulation, we believe the most parsimonious explanation of this finding is an extension of that presented by Dillon et al. (2007) that “the effects of emotion regulation on memory reflect strategic influences on stimulus elaboration” (p. 355).

As discussed in the introduction, previous research has suggested that older adults are more likely than younger adults to report using reappraisal strategies and are more effective at using these strategies when asked to do so. Moreover, research with younger adults has shown that although people report using a variety of strategies when given expressive regulation instructions, younger adults report using muscle control more than cognitive reappraisal (Demaree et al., 2006). It is possible that the older adults were more likely to use indirect strategies like reappraisal to control their facial expressions, whereas younger adults were more likely to rely on direct control of their facial muscles. This possibility would have yielded the pattern we saw with respect to expressive suppression: identical outward appearances but reduced recall in younger adults and increased recall in older adults. Future research that examines strategy selection would provide additional support for this interpretation.

There are a few caveats, however, to this explanation. First, the older adults in the current study did not report greater use of reappraisal in their daily lives than did younger adults, though this does not necessarily preclude their using it more in a laboratory situation. Second, the use of reappraisal has previously been linked to changes in self-reported affect; if older adults were reappraising during the suppression condition, we might have expected a change in their mood. Given these two caveats, some caution is warranted in this interpretation.

One potential alternative explanation for the effect of expressive regulation on memory is through the impact of arousal on memory consolidation, rather than through attention to stimulus processing. As reviewed in the introduction, expressive regulation has been shown to cause increased physiological arousal, and increased physiological arousal has been shown to be at least partially responsible for the increase in memory for emotional compared to neutral material, through the action of the amygdala on memory consolidation processes in the hippocampus (e.g., Cahill & McGaugh, 1998; Phelps, 2006). If older adults were showing greater physiological arousal in response to suppression instructions, this may have increased their memory relative to the natural condition. We note, however, that previous studies have shown that younger and older adults do not differ in their physiological reactions to suppression instructions (Kunzmann et al., 2005). In the current study, we also did not find any age differences in self-reported arousal. Additional research that looks specifically at the consolidation process, for example, by varying the delay between encoding and recall, could help clarify the results.

A second alternative explanation is that age differences in experienced affect during suppression may have an influence on the memory results. That is, if older adults were having a less intense subjective reaction to the stimuli under suppression instructions, it may be easier for them to suppress their facial reactions than it is for younger adults and would perhaps lead to less of a decrease in memory. Although this argument has been raised in previous research, we do not think that is the case here. As described above, both self-reported affect and observer-rated emotional expressivity were equivalent in the natural condition, suggesting that the initial and unregulated response to the pictures was similar for older and younger adults. In addition, the only age difference in self-reported affect occurred for suppression to positive pictures, but the memory effect was stronger for negative pictures. If affect does have an influence on the results, we believe it is through the same basic strategy difference proposed above: If older adults are reappraising, they may indeed be having a less intense emotional reaction to the stimuli during the suppression condition than are younger adults.

The discussion thus far has been focused on the effects of expressive suppression, as that was where the age differences in memory were found. It should be noted that we were unable to replicate the previous finding that enhancement resulted in decreased memory in younger adults, although this effect may have been obscured by significant variability in memory performance in the enhance condition. This increased variability could indicate that a greater range of strategies was used in the enhance condition. Although enhancement may require effort, which could decrease memory, it also may require more attention to the emotional aspects of a stimulus, which may increase memory. These two processes could cancel each other out, resulting in no net increase or decrease in memory as was found in the current study.

CONCLUSION

In summary, unlike younger adults, older adults can successfully enhance and suppress their facial expressions at little to no cognitive costs. Although the exact mechanism behind this effect, whether related to stimulus processing at encoding, arousal influences on consolidation, or the impact of suppression on affect, cannot be determined by the current research, this finding strongly suggests that older and younger adults are achieving expressive suppression through different strategies. Future research should be directed at replicating the current effect and determining the mechanism responsible for the decreased cost of suppression in older adults.

FOOTNOTES

1. Young adults produced an average of 11.23 total responses (*SD* = 6.93); of these, an average of 0.04 (*SD* = 0 .20) responses were coded as “disagreements,” and an average of 0.27 (*SD* = 0.61) responses were coded as “no matches.” Older adults produced an average of 9.68 total responses (*SD* = 4.32); of these an average of 0.23 (*SD* = 0.75) responses were coded as “disagreements,” and an average of 0.81 (*SD* = 0.90) responses were coded as “no matches.” Therefore, a greater percentage of responses was discarded from the older adults (10.7%) than from the young adults (2.7%), $t(99) = 4.55$, $p < .001$; this age difference in discarded responses is not unusual for this type of data (e.g., Charles et al., 2003; Emery & Hess, 2008).

2. Given recent evidence that working memory capacity can influence the ability to control facial expressions of emotion (Schmeichel et al., 2008), we performed an additional Age Group ×

Instruction analysis on Overall Expressivity scores, using (centered) Operation Span scores as a covariate. This analysis showed main effects of Operation Span, $F(1, 89) = 9.43$, $p < .05$, $\eta^2_p = .10$, and instruction, $F(2, 178) = 180.89$, $p < .05$, $\eta^2_p = .67$, and an Instruction × Operation Span interaction, $F(2, 174) = 15.93$, $p < .05$, $\eta^2_p = .15$. Consistent with Schmeichel et al. (2008), participants with higher working memory capacity (regardless of age) showed greater modulation of expression across instructions.

3.These recall rates are similar to those found in other studies using recall of IAPS pictures (e.g., Charles et al., 2003; Dillon et al., 2007).

4. Mauchly's test of sphericity suggested that there was a significant difference in the amount of variance across the six conditions, as evidenced by a significant chi-square value for the Instruction × Valence effect, $\chi^2(2, N = 101) = 7.35$, $p = .03$. Applying a Greenhouse–Geisser correction to the results does not change any of the significance tests reported here.

5. We acknowledge that the measures of affect and arousal were taken at a block level after all pictures in a condition had been presented and not at a picture-by-picture level. This leaves open the possibility that there were age differences in the reaction to individual pictures that are not captured by these single, somewhat retrospective ratings. Given, however, that the objective ratings of expressivity were not significantly different between older and younger adults, we do not think this is the case.

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